International Journal of Mechanical and Production
Engineering Research and Development (IJMPERD)
ISSN(P): 2249-6890; ISSN(E): 2249-8001
Vol. 3, Issue 5, Dec 2013, 73-78


# STUDY ON MECHANICAL BEHAVIOUR OF CARBON FIBER REINFORCED EPOXY COMPOSITES

**B. NAGA MAHALAKSHMI & V. VARA PRASAD**

Department of Mechanical Engineering, JNTUK, Andhra Pradesh, India

## ABSTRACT

Fiber-reinforced polymer composites have played a dominant role for a long time in a variety of applications for their high specific strength and modulus. The fiber which serves as a reinforcement in reinforced plastics may be synthetic or natural. Past studies show that only natural fibers such as bamboo, jute, coconut etc., have been used in fiber-reinforced plastics. Although glass and other synthetic fiber reinforced plastics possess high specific strength, their fields of application are very limited because of their inherent higher cost of production. In this connection, an investigation has been carried out to make use of carbon, a synthetic fiber. The present work describes the development and characterization of a new set of synthetic fiber based polymer composites consisting of carbon as reinforcement and epoxy developed composites are characterized with respect to their mechanical characteristics. Experiments are carried out to study the effect of fiber weights on mechanical behavior of these composites. In the present work, carbon composites are developed and their mechanical properties are evaluated.

**KEYWORDS:** Fiber - Reinforced Polymer Composites, Carbon Composites, Mechanical Properties

## INTRODUCTION

## EXPERIMENTAL WORK

### MATERIALS

The raw materials used in this work are Epoxy resin, Carbon fiber, Hardener

### PREPARATION OF MOULD

- Glass plates of dimension 200x200x3 mm are selected as a base for the mould.
- One set of piece has a dimension of 200x25x3 mm and other set has 150x25x3mm
- Glass pieces are attached to base plate with the help of araldite.
- Care should be taken that no gap should be present at corners of the attachment.
- This glass moulds are kept one day to open air to get firm attachment.

### NOMENCLATURE

**Table 1: Nomenclature Used in the Present Work**

| Name | Composition |
|---|---|
| C | PURE EPOXY RESIN |
| C1 | EPOXY RESIN+2g CARBON FIBER |
| C2 | EPOXY RESIN+4g CARBON FIBER |
| C3 | EPOXY RESIN+6g CARBON FIBER |
| C4 | EPOXY RESIN+8g CARBON FIBER |

## PREPARATION OF COMPOSITE SPECIMENS

### Preparation of C1 (Epoxy + 2g Carbon Fiber)

In this case, take epoxy resin, and hardener and mix it. Glass mould is placed on a plane surface, then the mixed solution is poured uniformly on to the mould and along with this 2g of Carbon fiber is placed in the mould and allowed it to dry for one day. After one day keeps it in the furnace for post curing process. This helps in removing the specimen from the mould and also the properties enhances by using this process. This procedure will be same for the other composite plates but they differ only in their proportions of natural fiber and resin

### MECHANICAL TESTING OF SPECIMENS

### Tensile Test

The Tensile test is performed on specimens according to ASTM test standard D638-03 on a Universal Testing Machine Instron3369. The cross head speed was maintained at 2 mm/min, at a temperature 22 $^0$C and humidity 50%. In each case three samples are taken and average value are recorded.

### Procedure

The test process involves placing the test specimen in the testing machine and applying tension to it until it fractures. During the application of tension, the elongation of the gauge section is recorded against the applied force. The data is manipulated so that it is not specific to the geometry of the test sample. The machine does the calculations as the force increases, so that the data points can be graphed into a stress-strain curve.

### Flexural Test

Flexural test were performs using 3-point bending method according to ASTM D790-03 procedure. The specimens were tested at a cross head speed of 2 mm/min, at a temperature 22 $^0$C and humidity 50%. In each case three samples are taken and average values are recorded.

### Procedure

Most commonly the specimen lies on a support span and the load is applied to the center by the loading nose producing three point bending at a specified rate. The parameters for this test are the support span, the speed of the loading, and the maximum deflection for the test. These parameters are based on the test specimen thickness and are defined differently by ASTM and ISO**.**

### Impact Test

A method for determining behavior of material subjected to shock loading in bending, tension, or torsion. The quantity usually measured is the energy absorbed in breaking the specimen in a single blow, as in the Charpy Impact Test, Izod Impact Test, and Tension Impact Test.

### Procedure

An arm held at a specific height (constant potential energy) is released. The arm hits the sample and breaks it. From the energy absorbed by the sample, its impact energy is determined.

## RESULTS AND DISCUSSIONS

### Effect of Fiber Percentage on Mechanical Characteristics of the Composites

The characterization of composites reveals that the fiber volume percentage is having significant effect on the mechanical properties of composites.

The properties of the composites with different fiber percentages are presented in the Table 2

**Table 2: Properties of the Composites with Different Fiber Percentages**

| Composition | Tensile Strength(Mpa) | Flexural Strength(Mpa) | Impact Strength(J/M) |
|---|---|---|---|
| C | 19.7 | 6.1 | 0.06 |
| C1 | 20.4 | 8.0 | 0.24 |
| C2 | 71.6 | 8.3 | 0.38 |
| C3 | 75.5 | 8.7 | 0.54 |
| C4 | 39.5 | 8.3 | 0.54 |

**Effect of Fiber Weight Percentage on Tensile Properties**

**Tensile Strength**

The effect of fiber weight percentage on Tensile strength is shown in figure 1. It is seen that the tensile strength increases with introduction of carbon fiber i.e., from 19.7 Mpa in C to 75.5 Mpa in C3 (i.e., epoxy +6g carbon). This is because of the strength provided by the carbon fibers into the matrix. This tensile strength shows a decreasing pattern as the fiber percentage increases as shown below. This is because of the weak interface between the matrix and reinforcement.

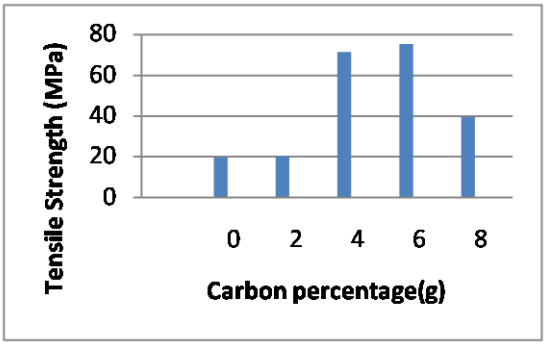


**Figure 1: Effect of Fiber Percentage on Tensile Strength**

**Effect of Fiber Percentage on Flexural Properties**

**Flexural Strength**

The effect of fiber weight percentage on Flexural strength is shown in figure 2. It is seen that the Flexural strength increases with introduction of carbon fiber i.e. from 6.1 Mpa in C to 8.7 Mpa in C3 (i.e. epoxy + 6g carbon). This is because of the strength provided by the carbon fibers into the matrix. This flexural strength shows a decreasing pattern as the fiber percentage increases as shown below. This is because of the weak interface between the matrix and reinforcement.

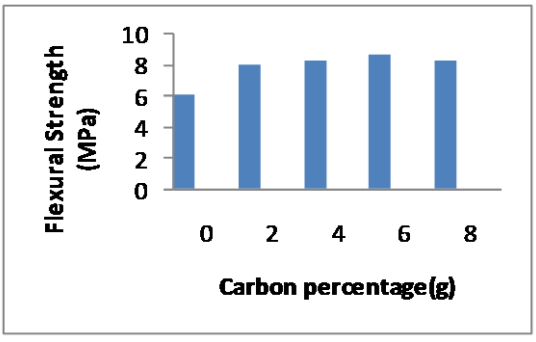


**Figure 2: Effect of Fiber Percentage on Flexural Strength**

### Effect of Fiber Percentage on Impact Properties

### Impact Strength

The effect of fiber weight percentage on impact strength is shown in figure 3. It is seen that the impact strength increases with introduction of carbon fiber i.e. from 0.06 J/m in C to 0.54 J/m in C3 (i.e. epoxy + 6g carbon). This is because of the strength provided by the carbon fibers into the matrix. This impact strength shows a decreasing pattern as the fiber percentage increases as shown below. This is because of the weak interface between the matrix and reinforcement.

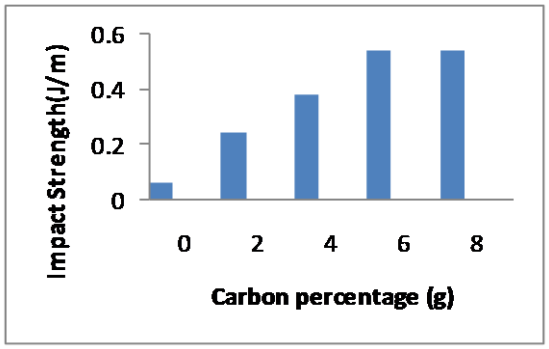


**Figure 3: Effect of Fiber Percentage on Impact Strength**

## CONCLUSIONS

These experimental investigation of mechanical behavior of carbon fiber reinforced epoxy composites leads to following conclusions.

- This work shows that successful fabrication of carbon fiber reinforced epoxy composites with different fiber weights is possible by simple hand lay-up technique.
- It has been noticed that the mechanical properties of the composites such as tensile strength, flexural strength and impact strength of the composites are greatly influenced by the fiber weights.
- The mechanical properties of the carbon fiber reinforced matrices show optimum strengths when applied with 6g carbon by weight.
- It is observed that the mechanical Properties increases steadily till 6g carbon and then decreases with further increase in the weight of carbon fiber.

## REFERENCES

1. Shaffer, G.D. "An Archaeomagnetic Study of a Wattle and Daub Building Collapse." Journal of Field Archaeology, 20, No. 1. Spring, 1993. 59-75. JSTOR. Accessed 28 January 2007
2. "Minerals commodity summary – cement – 2007". US United States Geological Survey. 1 June 2007. Retrieved 16 January 2008.
3. Heather Lechtman and Linn Hobbs "Roman Concrete and the Roman Architectural Revolution", Ceramics and Civilization Volume 3: High Technology Ceramics: Past, Present, Future, edited by W.D. Kingery and published by the American Ceramics Society, 1986; and Vitruvius, Book II:v,1; Book V:xii2

4. Sravani Gullapalli; Michael S. Wong (May 2011). "Nanotechnology: A Guide to Nano-Objects". Chemical Engineering Progress: 28–32.
5. Dmitri Kopeliovich Carbon Fiber Reinforced Polymer Composites. substech.com
6. Basic Properties of Reference Crossply Carbon-Fiber Composite. Oak Ridge National Laboratory (February 2000)
7. Ismail, N. "Strengthening of bridges using CFRP composites." Beijing, 217–224.
8. Rahman, S. (November 2008)."Don't Stress Over Prestressed Concrete Cylinder Pipe Failures ". Opflow Magazine, American Water Works Association: 10–15
9. "The Perils of Progress". Retrieved February 16, 2013.Bicycling Magazine, January 16, 2012
10. "Carbon Bicycle and Component Care". Retrieved February 16, 2013.BicycleWarehouse.com
11. "Inside Calfee Design's Carbon Repair Service". Bicycling Magazine. Retrieved February 16, 2013.